

Task 2 High Resolution Change Summary

Final Report February 1, 2013

As part of a joint grant with EPA through the Washington Dept. of Ecology, WDFW conducted a High Resolution Change Detection (HRCDD) project for two Washington Resource Inventory Areas (WRIAs) for the 2006-2009 time period as well as Kitsap Co. for the 2001-2006 time period. The intent of this project was to examine development and forestry activities during the observed time periods with respect to wetlands being mapped by NOAA as Task 1 of the EPA-grant. The spatial analysis of the change locations and wetland locations also includes four previously mapped WRIAs during the same time period. In all, 3.4 million acres of the Puget Sound basin are included in this analysis, representing roughly 38% of the Puget Sound land area.

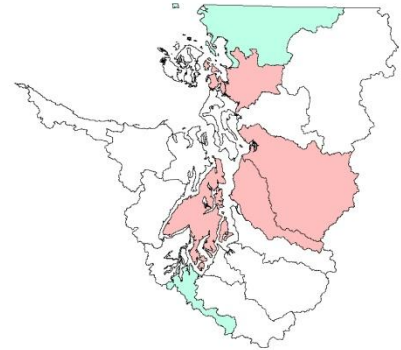


Figure 1: WRIAs in Jade were mapped as part of the EPA Wetland change grant

Types of changes mapped

The major change events mapped through this procedure are related to loss of vegetation events such as clearing for development or forestry. HRCDD is a combination of statistical modeling from training data and analyst review of potential changes. Images from two time periods are subjected to a band-wise differencing and a subsequent multi-band segmentation step. The segmentation procedure incorporates spectral information from both time periods to create spectrally homogenous polygons/segments for the entire image area. A sample is taken from the segments, classified by an analyst, and used to create a statistical model predicting the probability of change for all segments. In the final accuracy assessment step, segments with a probability of change greater than a specific threshold (usually a maximum of 25%) are reviewed by an analyst for errors of commission. During the review process, each mapped change is attributed with one of three change categories, development, forestry/unknown or natural. Changes are tagged as development if they show new structures, obvious site preparation or are adjacent to residential/commercial areas. This designation assumes a low probability that a changed location will return to its previous state. Areas of rotational forestry are usually intended to continue producing forest products and as such are not permanent changes with regard to hydrologic function and habitat utility. This designation primarily indicates a lack of knowledge about a future state. The last category of change noted is for locations that have changed due to natural losses of vegetation, most commonly due to changes in stream course. As wetlands are often adjacent to other hydrologic features we expect a fair amount of natural change will occur close to associated wetlands.

Study Areas

While the NOAA task 1 covers all of western Washington, the High Resolution Change Detection portion only covers parts of Puget Sound. Data exists for all of Puget Sound for 2006 and 2009, so the two WRIAs mapped in those time periods are an extension of continuing work towards mapping all of Puget Sound.

WRIA 01 Nooksack 2006-2009

The Nooksack watershed covers 816,000 acres of northwestern Washington state with urban and agricultural areas to the west and National Forest to the east. We estimated 10,689 acres of change with a mapped percentage of 71% which included 1,386 acres in 764 locations which seemed related to development.

WRIA 13 Deschutes 2006-2009

The Deschutes watershed is a long skinny valley fed by the Cascades and Mount Rainier and ending at the south end of Puget Sound. It covers 172,109 acres with the north portion primarily urban including the state capitol, Olympia, and surrounding cities. We estimated 5,315 acres of change with 94% mapped including 1,814 acres in 2,107 locations being related to development.

WRIA 15/Kitsap Co. 2001-2006

Kitsap Co. takes up just over half (262,000 acres) of the total area of WRIA 15 (425,000 acres). WRIA 15 was mapped previously for the 2006-2009 period and those results are included in the overall '06-'09 analysis. As part of this project we obtained from Kitsap Co. 2001 imagery comparable to the NAIP image products used for the 2006-2009 analysis.

Overall change results for '06-'09

In the six WRIAs mapped so far (1, 3, 7, 8, 13, 15) we have documented 11,774 change events covering 34,899 acres. Of those locations, 8,020 covering 9,713 acres were marked as related to development. While this only represents 27.8% of overall mapped change, it likely represents a minimum fraction attributable as permanent conversion to human use.

Puget Sound wetland polygon layer summary

The wetland pixels from NOAA's Task 1 wetland layer were extracted as polygons representing contiguous areas. The proportions of each polygon in different wetland types was calculated and polygons were labeled with their majority type.

MaxType	FREQUENCY	SUM_Acres
Estuarine Aquatic Bed	1080	30163
Estuarine Emergent Wetland	4233	23837
Estuarine Scrub Shrub Wetland	1	6
Palustrine Aquatic Bed	906	5333
Palustrine Emergent Wetland	3668	48423
Palustrine Forested Wetland	12365	129425
Palustrine Scrub-Shrub Wetland	3448	30034

Table 1: Frequency and areal totals for Puget Sound wetlands used for change analyses.

The wetland polygons totaled 25,701 with 1,001 single pixel polygons and 3,811 with area less than 1 acre. The total area covered was 258,521 acres with about 80% of the area in palustrine wetlands.

Wetland-change analysis methods

To examine wetlands and change we used a series of increasing buffer distances to examine the potential influence of development and forestry on wetland areas. We initially intersected the mapped wetland locations with mapped changes to find the frequency of direct disturbance. We then used 100-m buffers out to 300-m to gauge potential local influences. WA DOE recommendations for wetland buffers range from 50ft to 300ft, therefore the direct intersections and 100-m buffer results will be most relevant to critical area ordinance issues. The 200m and 300m buffers will be more relevant towards understanding matrix effects on wetlands from nearby changes.

Direct intersection results 06-09 change

With a 0-m buffer, 976 wetland polygons were intersected by a change polygon. Those intersections covered 606 acres with 431 acres coming from 127 events larger than 1 acre. Natural changes, mostly stream course alterations, accounted for 140 acres, development-related change accounted for 103 acres while forestry/undetermined change made up 60% of the area at 363 acres.

Buffer results 06-09 change

Wetlands and streams collect water from their surroundings, which indicates that changes in the local area can affect wetland function. For this reason we examined the amount of change taking place within different distances of our wetland layer. While natural changes comprised 23% of the direct wetland-change intersection, by the 100-m buffer, little additional natural change was added.

Buffer	Development	Forestry/Unknown	Natural	Change (acres)	Total Buffer Area (acres)	Prop
Intersect	103	363	140	606	111815	0.5%
100-m	1159	2308	207	3674	458919	0.8%
200-m	2623	4838	218	7679	787119	1.0%
300-m	3947	7405	227	11579	1094358	1.1%

Table 2: Cumulative 2006-2009 mapped change (acres) within different radii of mapped wetland areas.

Buffer results 01-06 change

HRC

We performed our change analysis on Kitsap Co. for the 2001 to 2006 period due to the acquisition of 1-m aerial photo data from Kitsap Co. which was similar to our NAIP data. This time period corresponds with the most recent CCAP change detection product and provides data for comparing wetland change data and local effects of change between the two methods. When we intersected the 4,290 change locations with the wetland data we found 198 intersects covering 78.6 acres. The majority, 55.4 acres, were in changes designated as forestry/unknown. Of the 8,754 acres mapped as change, 48% are within 300-m of a wetland. However, roughly 50% of the land area of Kitsap Co. is within 300-m of a wetland so that is an expected result.

	Development	Forestry/Unknown	Total	Area	Prop
Intersect	23	55	79	14231	0.6%
100-m	472	743	1215	55024	2.2%
200-m	1187	1499	2686	100162	2.7%
300-m	1956	2212	4168	142697	2.9%

Table 3: Cumulative 2001-2006 HRCD mapped change in Kitsap Co. within different radii of mapped wetland areas.

CCAP

Change polygons for the 2001-2006 CCAP data were derived by extracting the changed pixels in the CCAP raster to polygons. Those polygons were then compared to the same high resolution imagery as the HRCD polygons were created from. Commission errors were removed from the CCAP data set, defined as any CCAP polygon showing less than 25% change between the two time periods. The 2001 image date for CCAP was a composite of several dates spanning 1999-2003 (Harold, N. personal communication).

	Development	Forestry/Unknown	Total	Area	Prop
Intersect	0	30	30	14231	0.2%
100-m	37	535	572	55024	1.0%
200-m	103	1156	1259	100162	1.3%
300-m	193	1736	1929	142697	1.4%

Table 4: Cumulative 2001-2006 CCAP mapped change in Kitsap Co. within different radii of mapped wetland areas.

Comparison with Thurston Co. Local Wetland Map

We obtained a locally derived wetland map for Thurston Co. and compared it to NOAA's new wetland map. Our comparison will focus on the portions of Thurston Co. in WRIA 13. The local and NOAA wetland polygons were clipped to the WRIA boundaries. Open water and stream courses were removed where feasible from the local map. We will first compare the total wetland areas mapped by the two sources and then tally the intersection of the maps.

To compare change rates we will buffer all wetland layers at 100, 200 and 300-m intervals and intersect the original wetland maps and the buffered maps with our 2006-2009 HRCD change polygons. These will represent two views of wetland impacts as based on the local vs. NOAA source data.

WRIA 13 2006-2009 Comparison of Change with Thurston Co. and NOAA Wetland Polygons

The NOAA wetland layer has 841 wetlands in WRIA 13 with a total area of 8,683 acres. The Thurston Co. wetland layer has 1,768 wetlands with a total acreage of 9,520 acres. The intersection of the two wetland layers produces 1,157 pieces with a total acreage of 4,085 acres. Figure 2 shows the northern portion of WRIA 13 which occurs at the south end of Puget Sound. There are several reasons for the differences between the Thurston Co. wetland layer and the NOAA wetland layer. Most importantly, the Thurston Co. map was created over a decade ago with portions dating back to 1992.

Some of the difference will simply be due to wetland loss during the subsequent period. Secondly there appear to be some definitional differences where NOAA is mapping more shoreline areas as wetland which does not occur in the Thurston Co. map. Also the large blue wetland in the northeast of the map

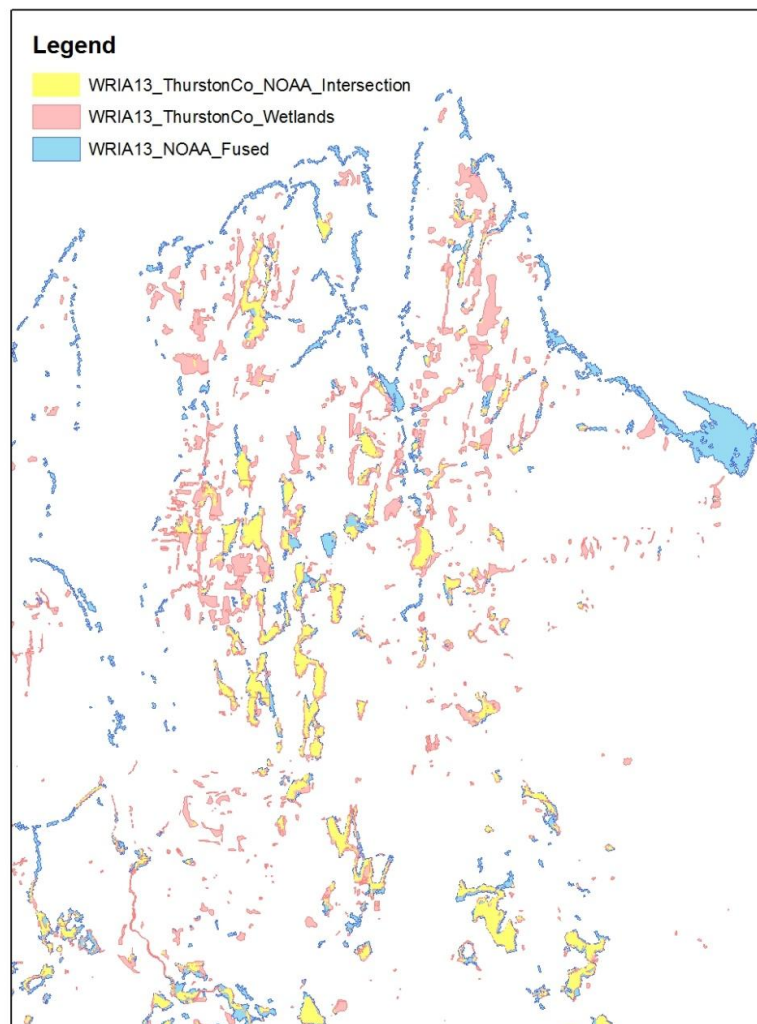


Figure 2: Wetland mapping differences between NOAA and Thurston Co. maps



is the Nisqually delta (449 acres in NOAA polygon), the subject of a major multi-million dollar restoration project which occurred after the completion of the Thurston Co. map.

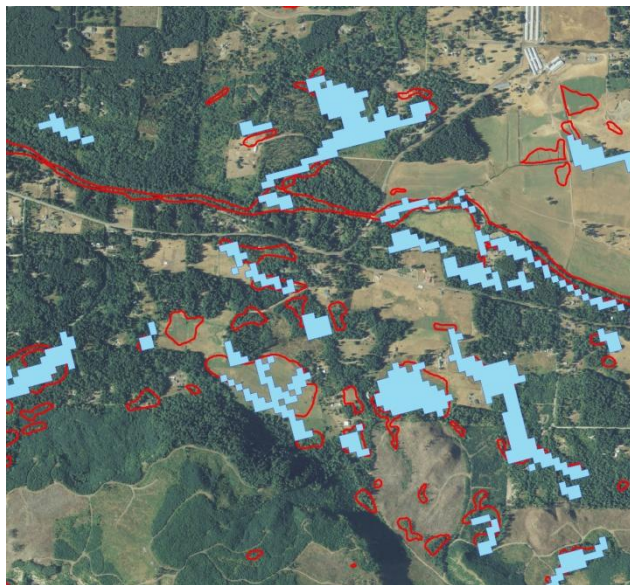
Table 5 shows the acreages of change based on the different maps and the rates of change within different buffers surrounding the mapped wetlands. For forestry/indeterminate type changes and natural changes, the total change area was similar between the two maps. For change apparently related to development, the Thurston Co. map had about 60% more mapped change than the NOAA wetlands map.

2006-2009							
WRIA 13	HRCD	NOAA Wetlands					
	Development	Forestry/Unknown					
	Change	Change	Natural	Total	Buffer Area	Prop	
Intersect	11	4	10	25	8683	0.3%	
100-m	172	202	20	394	34082	1.2%	
200-m	427	503	20	950	58104	1.6%	
300-m	629	830	20	1479	80131	1.8%	

2006-2009							
WRIA 13	HRCD	Thurston Co. Wetlands					
	Development	Forestry/Unknown					
	Change	Change	Natural	Total	Buffer Area	Prop	
Intersect	20	15	12	47	9520	0.5%	
100-m	336	324	20	680	41272	1.6%	
200-m	747	653	20	1420	68473	2.1%	
300-m	1018	895	20	1933	89270	2.2%	

Table 5: Comparison of change amounts in acres surrounding wetlands based on the WRIA 13 HRCD change map and intersected with the NOAA wetland layer and the Thurston Co. wetland layer.

The Thurston Co. layer had more small wetlands mapped which may contribute a large proportion of the differences between the total change amounts. The average size of a non-intersected wetland from the



Thurston Co. layer was 1.57 acres while the average size of the intersected wetlands was 12.5 acres. Figure 3 shows Thurston Co. mapped wetlands in red outline and NOAA mapped wetlands in blue. The Thurston Co. map has many more small wetlands and also shows more wetlands in agricultural areas. Some of these may have been converted since the 1992 county layer. The Thurston layer also includes more of the thin linear river course as wetlands.

Figure 3: Size comparison of mapped wetlands by Thurston Co. and NOAA